Conclusions: SW-VMAT plans aiming at sparing swallowing structures are feasible, with the potential to reduce NTCP swallowing dysfunction with respect to conventional ST-VMAT.

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Proton breast treatments: eclipse vs Monte Carlo Fluka dose comparison study

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Purpose/Objective: We present a Fluka Monte Carlo (MC) simulation study for proton treatments based on Varian Eclipse proton plans for left breast cancers including the internal mammary chain. Doses calculated in TPSs are usually accurate within the primary field, but less accurate outside. With the MC treatment verification we can not only find possible inaccuracies in the delivered dose to the regions of main interest (PTV and OAR like heart and left lung) mainly due to body inhomogeneities close to the PTV (i.e., ribs and lung), but also find the accurate dose deposited in other healthy tissues not included in the TPS optimisation (contra lateral lung, contra lateral breast). Doses deposited by other particles not generated in the TPS, but usually created during a real treatment, such as neutrons and light ions, are also accounded for in the MC. All of this allows us to more accurately determine toxicity to healthy tissues and risk of secondary malignancies.
Materials and Methods: Before starting any comparison between the MC and the TPS, the virtual CAP GENERAL machine used in the proton Eclipse TPS had to be accurately characterised. In this context studies were performed using virtual water phantoms to determine the beam characteristics (energy, energy spread, spatial spread) and so to prove the equivalence of Eclipse plans in Fluka. Eighteen different patient plans for breast treatments were then performed using Eclipse and the information about the used beams included in the TPS RTPLAN files were extracted and converted to plans in Fluka. This allowed us to perform dose comparisons between plans and simulations in the entire upper body of the patient.
Results: In this work we developed a method of performing treatment verification of Eclipse breast plans with the Monte Carlo Fluka and show that dose differences up to 4% in the PTV and up to 70% in other healthy tissues (i.e., contra lateral breast) can be observed when the TPS plans are compared with Fluka simulations of the same plans.
Conclusions: While the Varian TPS for conventional radiotherapy is widely used, the proton Eclipse TPS is only used in a few facilities, resulting in a dearth of comparison studies. In particular breast treatments with protons are in the early stages of investigation and not many groups so far have demonstrated the accuracy of TPSs with respect to this treatment site. With this study we demonstrate that treatment verification with Monte Carlo simulations is essential to better determine the dose deposited in the entire patient body, and in particular to the healthy tissues.

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Dosimetric evaluation of arc-based modulated electron radiation therapy

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Purpose/Objective: To perform a dosimetric evaluation of arc-based modulated electron radiation therapy (arc-MERT) using a direct aperture optimization (DAO) algorithm.
Materials and Methods: An arc-MERT plan was mimicked by setting a series of field ports with small angle increments (between 6° and 15° depending on the case). When possible, a single isocenter was used for the field set-up; this was not always possible due to the short source-to-skin distance (~70cm) used for MERT planning using the photon MLC for beam collimation. For each field port, beamlet dose distributions were generated for several different electron beam energies. A treatment plan is created by selecting and optimizing the shape and the weight of a certain number of initial apertures per beam energy and per field. Thus, different combinations of apertures can be investigated with the available field ports and beam energies. This approach was applied for two clinically motivated situations: a head and neck and a breast case. For the head and neck case, 13 field ports spanning a 140° arc were set up using multiple isocenters. For the breast case, 6 field ports spanning a 30° arc were set up using a single isocenter. For both cases, many plans were generated using different combinations of apertures (between 10 and 90 apertures per plan). The dose homogeneity to the PTV as well as the doses to organs at risk (OAR) were determined and compared to photon plans.
Results: Using arc-MERT, it is possible to achieve a high dose homogeneity to the PTV (V95%-V107% > 95%), which is similar to the photon plan. Good treatment plans can already be achieved using between 30 to 50 apertures and more than one electron beam energy. For the head and neck case, the organs at risk sparing was similar to the original VMAT plan, while the low dose bath could be substantially reduced with arc-MERT (V10% = 554 cc versus 1150 cc for VMAT). For the breast case, the high dose homogeneity to the PTV achieved with arc-MERT came at the cost of high ipsilateral lung doses (mean dose 20 Gy, V30Gy = 34%). If the CTV had to be adequately covered instead of the PTV (defined for tangential photon plans), the doses to the ipsilateral lung could be substantially reduced (mean dose 7.3 Gy, V30Gy=1%).
Conclusions: arc-MERT offers the potential to achieve high dose homogeneity to the PTV similar to photon plans and depending on the case also similar OAR sparing while reducing the low dose bath. More work is required to define which sites would most benefit from arc-MERT. This work is supported by the Swiss Cancer Research grant KFS-3279-08-2013.